



# PROTECT THE PLANET

Study circle



## ENERGY USE IN DAILY LIFE: TRANSPORTATION

This guide has been designed to help Centres/Groups of the Sathya Sai International Organisation (SSIO) facilitate a study circle on the topic of Transportation and its impact on the environment. It has been developed as part of a series of study circle guides that aim to look at energy use in daily life. This is part 3, with an estimated duration of one hour.

**Part 3 will cover:** *Different modes of transportation and their evolution, elements and energy sources used to power transportation, impact on the environment and how we can reduce dependence on transportation.*

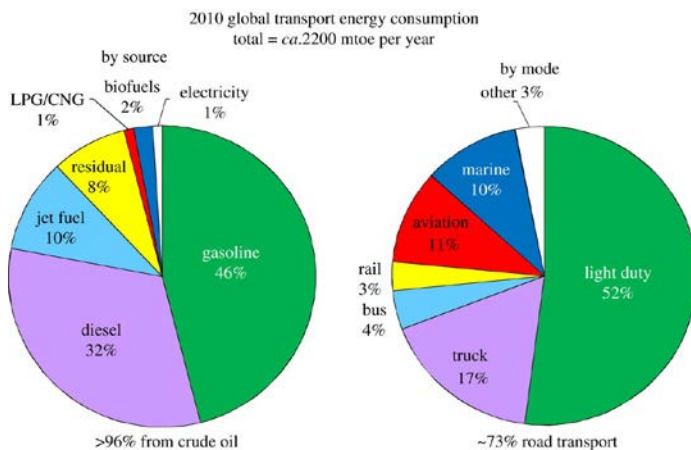
### PART 3

OPENING AND INTRODUCTION			
ACTIVITY	NOTE TO FACILITATOR	RESOURCES	DURATION
3 OM's or silent sitting followed by an opening prayer	Whether omkar or a minute of silent sitting is used depends on the audience this study circle is being delivered to. Either way, the objective of this activity is to help settle the group and establish group dynamics. This objective remains whether a prayer or short reading is used.		1 min
Introduce the topic of the day	<p>This study circle is part of the Serve the Planet (STP) initiative of the SSIO and is based on the theme '<b>Protect The Planet</b>' with a focus on 'Energy.'</p> <p><b>The purpose of this study circle is to better understand the impact of our transportation use on the planet and how it can be used responsibly to make the planet more sustainable.</b></p> <p>It is important to remain respectful and open at all times. Keep in mind that the study circle is about sharing and exploring the topic, and inspiring each other rather than 'finding the right answers.'</p>		1 min
TODAY'S DELIVERY			
ACTIVITY	NOTE TO FACILITATOR	RESOURCES	DURATION
Discussion on: <b>Transportation – meaning and evolution</b>	<p>Pose this question to the group: <b>What do you mean by Transportation?</b></p> <p>Once participants have shared their thoughts, the facilitator should round off the first question with the below concepts.</p> <p>Meaning of the English word 'Transportation' per the Cambridge Dictionary is 'the movement of people or goods from one place to another.'<sup>1</sup> Another meaning per the Cambridge Dictionary is 'a vehicle or system of vehicles, such as buses, trains,</p>	<p><b>Video 1:</b>  <a href="https://www.youtube.com/watch?v=0-XPufM4i8E">https://www.youtube.com/watch?v=0-XPufM4i8E</a>            (1 min 44 secs)</p> <p>(*Note if no video facilities are available</p>	5 mins

	<p>etc. for getting from one place to another.<sup>1</sup></p> <p><b>Do you know how Transportation evolved over time?</b></p> <p>You can play <b>Video 1</b> on the history of transportation and share the below points.</p> <p>The evolution of transportation is one of continuous innovation. Energy costs and supply often play a role in motivating innovation.<sup>2</sup></p> <p>If the group is interested in learning more about the history of transportation, <b>Attachment A</b> can be shared during the study circle (if time permits) or via email after the session.</p>	<p>on-site, participants can be sent ALL video links beforehand to watch at home prior to the study circle)</p> <p><b>Attachment A</b></p>	
<p>Discussion on: <b>Modes of transportation, elements and sources of energy</b></p>	<p><b>What are the various modes of transport available?</b></p> <p>Modes of transport are the means by which passengers and freight achieve mobility. These include walking, bicycle, motorbike, car, bus, taxi, train, ferry and aeroplane. These various modes of transport can be grouped into three broad categories – land, water and air transport.</p> <p>Transport of a person or cargo may involve one particular mode or multiple modes of transport. Mode of transport vary in cost, convenience, time, and environmental impact. Each mode has its own advantages and disadvantages.</p> <p><b>What are the elements of transportation?</b></p> <p>Different modes of transport make use of different types of vehicles, infrastructure and operation mechanisms.<sup>3</sup></p> <p>A <b>vehicle</b> is the non-living device that is used to move people and goods. Vehicles use steam engines, combustion engines, electric motors, jet engines or rockets for propulsion, and fuels are the energy sources that power these engines.<sup>3</sup></p> <p><b>Infrastructure</b> is the fixed installation that allows a vehicle to operate. It may refer to a roadway, terminal or facility used for parking and maintenance.<sup>3</sup></p> <p><b>Operations</b> simply mean the individual or entity who operates the vehicle.<sup>3</sup></p> <p><b>Group introspection:</b> Spend 5 minutes to discuss the following within your group:</p> <ol style="list-style-type: none"> <li>1. What is your main mode of travel on a day-to-day basis (going to work or school, shopping, running errands, etc.)?</li> <li>2. What factors determine your mode of transport: cost, convenience, time, environmental factors,</li> </ol>		<p><b>15 mins</b></p>

	<p>lack of other transport options, etc.?</p> <p><b>Energy sources used in transportation</b></p> <p>Different modes of transportation use the following sources of energy:</p> <ol style="list-style-type: none"> <li>1. Petroleum products: products made from crude oil and liquids that result from natural gas processing, including gasoline, diesel fuel, jet fuel, residual fuel oil, and propane</li> <li>2. Biofuels: ethanol and biodiesel</li> <li>3. Natural gas</li> <li>4. Electricity</li> <li>5. Hydrogen</li> </ol> <p>Most of the energy used in the transportation sector comes from fossil fuels (non-renewable energy).</p> <p><b>Energy sources are used in several major ways:</b></p> <ul style="list-style-type: none"> <li>● Gasoline is used in cars, motorcycles, light trucks and boats. Aviation gasoline is used in many types of airplanes</li> <li>● Diesel fuel (or distillate fuel) is used mainly by trucks, buses and trains, as well as boats and ships</li> <li>● Kerosene is used in jet airplanes and some types of helicopters</li> <li>● Residual fuel oil is used in ships</li> <li>● Biofuels are added to gasoline and diesel fuel</li> <li>● Natural gas is used as compressed natural gas and as liquefied natural gas in cars, buses, and trucks. Vehicles that use natural gas are often part of government and private vehicle fleets</li> <li>● Natural gas is also used to operate compressors to move natural gas in pipelines</li> <li>● Propane (a hydrocarbon gas liquid) is used in cars, buses and trucks. Most of the vehicles that use propane are part of government and private vehicle fleets</li> <li>● Electricity is used in mass transit systems and electric vehicles.<sup>4</sup> New tests show very good use of electric batteries in aircrafts<sup>5</sup></li> <li>● Hydrogen is used in cars and transit buses, and for spacecrafts<sup>6</sup></li> </ul> <p>Ethanol and biodiesel were actually some of the first fuels used in automobiles, but they were later replaced by gasoline and diesel fuel. Today, most of the biofuels used in vehicles are added to gasoline and diesel fuel. The transportation sector is the biggest consumer of oil in the world.<sup>7</sup></p> <p>Pose a question to participants: <b>Do you know which type of energy source is largely used in the transport sector, and which category of vehicles are being powered by them?</b> After the participants have shared</p>		
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their thoughts, show the below graph for discussion and further understanding.



**Figure 1. 2010 Global Transport Energy Consumption**  
 (Source: World Economic Forum. 2011 White paper: repowering transport Geneva, Switzerland: WEF)

Discussion on:  
**Environmental impacts of transportation and energy saving**

Share the scenario below to the group and ask them to spend a couple of minutes to contemplate: **How would one consider choosing a particular mode of transport while balancing time and environmental factors?**

Let us consider a scenario: when covering a 10-mile distance, which mode of transport would be the most environmentally friendly in terms of energy and fossil fuel consumption, and pollution and gas emissions – car, train, bus, boat, bicycle or walking?

Factors to consider may include the time efficiency of each transport type. Certain modes of transport cause zero emissions, but may not be time efficient (e.g. bicycle or walking). Similarly, certain modes of transport are very time efficient but cause a large amount of CO<sub>2</sub> emissions (e.g. aeroplane and car).

The purpose of this activity is to get people to try and balance convenience with the environmental impacts of using common modes of transport in their daily life.

Please have a look at **Attachment B** to understand the CO<sub>2</sub> per passenger kilometre ratio for various modes of transport.

Discuss the following question with the group and ask them to share their views on how transportation affects the environment: **What are the environmental impacts of using transportation?** Based on what is shared by the group, the below points can be used to support the discussion, if not already covered by the answers received.

Environmental impacts can occur at various stages such

**Video 2:**

<https://www.youtube.com/watch?v=Heqd7IH7ZTA>

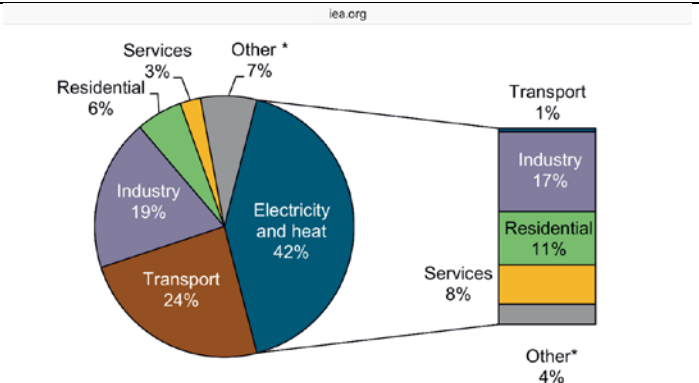
(1 min 39 secs)

Video on carbon footprint by transportation

**Attachment B**

**20 mins**

	<p>as:</p> <ul style="list-style-type: none"> <li>- infrastructure development</li> <li>- vehicle manufacturing</li> <li>- vehicle operation</li> <li>- vehicle maintenance</li> <li>- vehicle disposal</li> </ul> <p>The nature of environmental impact is related to the mode of transport, its energy supply systems, its emissions and the infrastructure with which it operates. While consuming large quantities of energy, especially oil, vehicles also emit numerous pollutants into the atmosphere such as carbon dioxide, nitrogen oxide etc., which have damaged many ecological systems.<sup>8</sup></p> <p>The energy consumption in the transport sector is the main cause of pollution. Transport requires energy mainly for vehicle operation and to some extent for manufacturing vehicles. Transport is a major source of air pollution by way of carbon emissions, including carbon monoxide, unburnt hydrocarbon, nitrogen oxide, tetraethyl lead, carbon dust particles and aldehydes. These emissions are also responsible for the increasing global warming. Another side effect of transport systems is the noise pollution they produce. Alongside this, land consumption, landscape damage and ecological degradation also result from infrastructure development.<sup>9</sup></p> <p>Major environmental impacts can be categorised into the following areas:<sup>10</sup></p> <ul style="list-style-type: none"> <li>● Climate Change</li> <li>● Air quality</li> <li>● Noise</li> <li>● Water quality</li> <li>● Soil quality</li> <li>● Biodiversity</li> <li>● Land occupancy</li> </ul> <p>To understand the environmental impacts in detail, refer to <b>Attachment C</b>.</p> <p>The transportation sector produces approximately 25% of the world's total CO<sub>2</sub> emissions.<sup>7</sup></p>	<p><b>Attachment C</b></p>	
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**Figure 2. World CO<sub>2</sub> emissions from fuel combustion by sector, 2015**

(Source: International Energy Agency, Publication: CO<sub>2</sub> Emissions From Fuel Combustion Highlights 2017, page no. 12)

Facilitator can read **Attachment D** to the group if the group is interested in additional data about consumption of energy by transport systems in the last three decades.

**How is transportation linked to energy saving and what energy can be saved in transportation?**

Energy saving can be achieved by reducing our reliance on transportation or by choosing alternative methods of transportation where energy consumption is less. Energy efficient modes of transport can drastically reduce energy consumption. E.g. A shift from private vehicles to public transport will decrease energy consumption and reduce the amount of CO<sub>2</sub> emissions. Similarly, energy consumption, both in passenger and freight traffic, will comparatively decrease when we move from air to road, road to rail and finally rail to water transport.

**Attachment D**

Group introspection/discussion:  
**How can we reduce our dependency on transportation and do our bit to Protect the Planet?**

**Group introspection:** Spend 5 minutes to go over the following questions:

1. Now that we have looked at the energy consumption of different modes of travel, could we switch to a more environmentally-friendly travel option for some or all of our daily activities?
2. What are the energy saving transport options you can think of for your daily use?
3. Could we carpool or invest in a more environmentally-friendly vehicle?

After the introspection session, the facilitator can present the following 'Energy Saving Tips for Transportation':

- Walk or ride a bicycle when travelling short distances; it is good for the environment and for our health as well. There are many cities that encourage walking and riding bikes

**15 mins**

	<ul style="list-style-type: none"> <li>• Do not use your private vehicles extensively. Try to use public transportation whenever possible</li> <li>• Remove extra boot/trunk weight in the car. Unwanted items like a flat tyre, unwanted luggage, especially heavy ones, can reduce the vehicle's mileage. The reduction is based on the percentage of extra weight (relative to the vehicle's weight) and affects smaller vehicles more than the bigger ones</li> <li>• Keep automobile fuel filters clean, save fuel and conserve energy</li> <li>• Keep the vehicle tuned up always. When a vehicle is running well, it uses nine per cent less fuel and thus, emits fewer toxic and noxious fumes</li> <li>• Do not use the clutch pedal as a footrest</li> <li>• Do not leave your vehicles idle. Beyond one minute, it is more fuel-efficient to switch off and restart your car when needed</li> <li>• Maintain the recommended tyre pressure<sup>11</sup></li> <li>• Carpool whenever possible. A few countries have dedicated traffic lanes for high occupancy vehicles, including carpool passengers. Also, ride-sharing technologies have been introduced in major cities, which allow a one-time shared ride at very short notice</li> <li>• Select a route and/or time where traffic is less</li> <li>• Live near to work or work a few days per month from home if possible</li> <li>• Replace your old car with a more fuel-efficient car</li> <li>• Go for electric vehicles or hybrid electric vehicles (Refer to the Resources section below)</li> <li>• Travel less and increase dependency on new technologies. Conference calls are good ways to interact with the team and clients, and help avoid the need to travel to meetings</li> <li>• Opt for public transport and use other energy saving techniques to reduce CO<sub>2</sub> emissions</li> <li>• Reduce the number of private vehicles per family and make optimum use of vehicles</li> <li>• Buy local products – this way, energy consumption, otherwise required on transporting products across great distances, can be avoided</li> </ul> <p>For additional practical tips on ways to reduce our energy footprint, please refer to the mini-booklet available at <a href="http://www.sathyasai.org/ya/serve-the-planet">http://www.sathyasai.org/ya/serve-the-planet</a>.</p> <p>Sathya Sai Baba answers one of the questions about reducing dependency, helping ourselves and protecting Mother Earth:</p>		
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	<p>“Though man is eager to attain peace, he confronts many obstacles in the path. Those who travel by train may be well acquainted with the slogan, “Less luggage, more comfort, make travel a pleasure.” Now, man is burdening himself with limitless desires. Because of this extra heavy luggage of desires, he finds it extremely difficult to carry on the journey of life. By such proliferation of desires, he loses his balance, moves far away from his goal, and even tends to go mad.</p> <p>It is for this reason that I have been stressing the need for ceiling on desires. By limiting your desires, you can attain peace to a certain extent. You have to exercise a check on your desires and make comforts to get the Grace of the Divine.” – Sathya Sai Baba (SSS 31.18: April 25, 1998)</p>		
<b>SUMMARY AND CONCLUSION</b>			
Closing summary of the session, what to expect in the next session, and homework	<p>So far, we have learned:</p> <ul style="list-style-type: none"> <li>● What is transportation and how has it evolved over time?</li> <li>● Modes of transportation, elements and sources of energy used to power transportation, and their resulting environmental impacts</li> <li>● How is transportation linked to energy saving?</li> <li>● How can we reduce our reliance on transportation and do our bit to protect the planet’?</li> </ul> <p><b><u>In PART 4 of this study circle, we will cover:</u></b></p> <p>The Evolution of Technology, its advantages and disadvantages, environmental issues, technology and spirituality, Ceiling on Desires in relation to technological products – distinguishing between wants and needs, and reducing our energy footprint.</p> <p><b><u>HOMEWORK and preparation for the upcoming session:</u></b></p> <ul style="list-style-type: none"> <li>● What can you do as an individual to reduce your use of transportation and your carbon footprint?</li> <li>● How can you reduce your reliance on transportation with the help of the ceiling on desires programme?</li> <li>● Transportation of goods contributes significantly to energy consumption. What changes can you make to the things you buy to reduce your carbon footprint?</li> <li>● To prepare for the next session, list out the different technologies being used on a daily basis and their subsequent environmental impact.</li> </ul>	<p><b>Video 3:</b>  <a href="https://www.youtube.com/watch?v=c4iVCJ00BYA">https://www.youtube.com/watch?v=c4iVCJ00BYA</a>  (2 mins 47 secs)</p> <p>Video on Transportation – recap</p>	<b>2 mins</b>
<b>CLOSE</b>	Closing prayer or reading. Prayer for universal peace – <i>Om Shanti, Shanti, Shanti.</i>		<b>1 min</b>



**Note:** Ideally, there should be two facilitators for groups of ten or more participants. The first facilitator will conduct the study circle. The second facilitator observes group dynamics and informs the first facilitator of any lethargy or confusion from participants. This second facilitator also conducts the opening activity (E.g. Omkar) and the sharing of insights at the end. This helps give a variety of voices to the participants, and gives the first facilitator the necessary space to capture and absorb important feedback and learning points for insights sharing.

## Attachment A

### Evolution of Transportation

The first forms of road transport involved animals, such as horses (domesticated in the 4th or 3rd millennium BCE), oxen (from about 8000 BCE) or humans carrying goods over dirt tracks. Many early civilizations, including Mesopotamia and the Indus Valley Civilization, constructed paved roads. The first watercrafts were canoes cut out from tree trunks. Subsequently, early water transport began with ships that were either rowed or used the wind for propulsion, or a combination of the two. The importance of water served as a foundation for most cities that established sites for trading on riverbanks and seashores, often at the intersection of two bodies of water. Until the Industrial Revolution, transport remained slow and costly, and production and consumption gravitated towards as close to each other as feasible.<sup>2</sup>

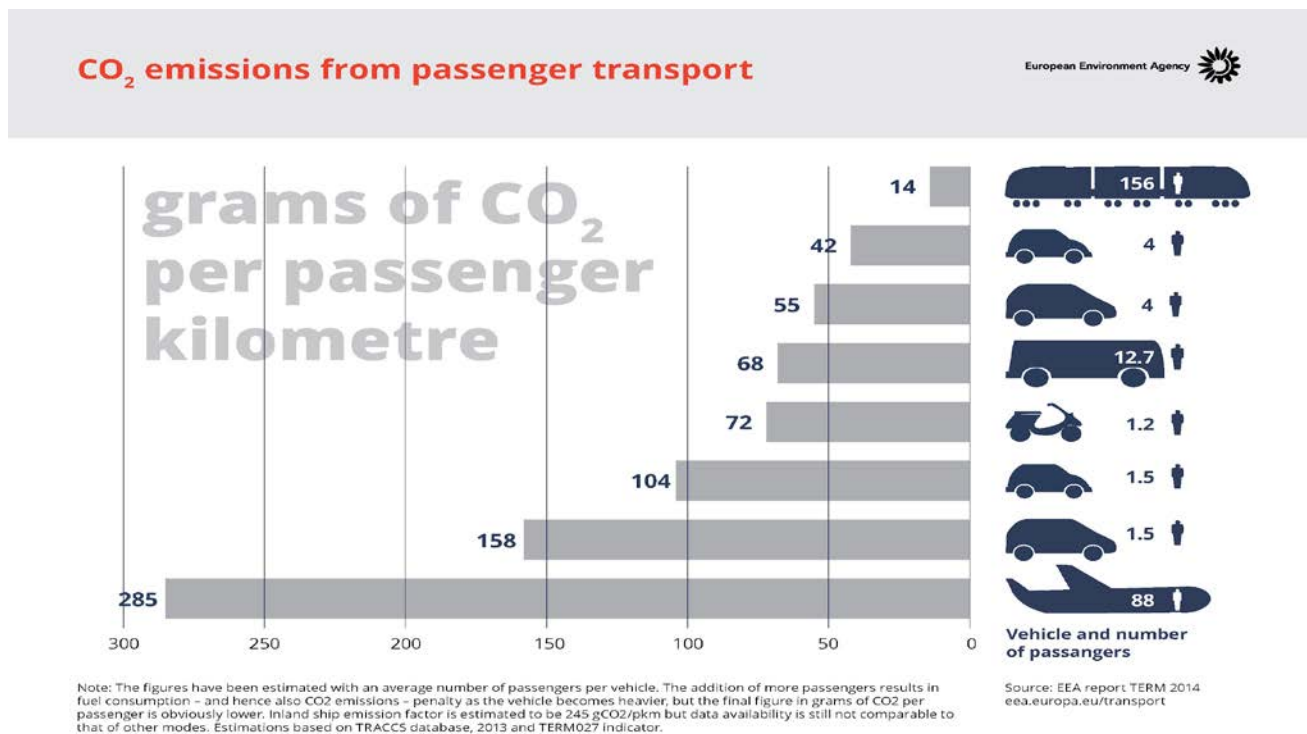
The Industrial Revolution in the 19th century saw a number of inventions fundamentally change transportation. With telegraphy, communication became instant and independent of the transport of physical objects. The invention of the steam engine, closely followed by its application in rail transport, made land transport independent of humans or animals. Both speed and capacity increased rapidly, allowing for greater specialisation with more and more manufacturing operations being located independently of the natural resources needed. The 19th century also saw the development of the steam ship, which sped up global transport.<sup>2</sup>

With the development of the combustion engine and the automobile around the 1900s, road transport became competitive once again, and mechanical private transport was born. The first 'modern' highways were constructed during the 19th century with macadam. Later, tarmac and concrete became the dominant paving materials. In 1903, the Wright brothers demonstrated the first successful controllable airplane, and after World War I (1914–1918), air transportation quickly became a fast way to transport people and goods over long distances.<sup>2</sup>

After World War II (1939–1945), the automobile and airline industry took a larger share of transportation activities, reducing rail and water to freight and short-haul passenger services. Scientific spaceflight began in the 1950s, with rapid growth until the 1970s, when interest dwindled. In the 1950s, the introduction of containerisation resulted in massive efficiency gains in freight transport, fostering more deeply-connected globalisation. International air travel became much more accessible in the 1960s, with the commercialisation of the jet engine. Alongside the growth in automobiles and motorways, rail and water transport declined in relative importance. After the introduction of the bullet train in Japan in 1964, high-speed railways in Asia and Europe have started attracting passengers to road-based long-haul routes, away from the airlines.<sup>3</sup>

## Attachment B

### CO<sub>2</sub> per passenger kilometre ratio for various modes of transport



**Figure 3. CO<sub>2</sub> emissions from passenger transport**

(Source: EEA report TERM 2014 [eea.europa.eu/transport](http://eea.europa.eu/transport))

## Attachment C

**Major environmental impacts can be categorised as follows:**<sup>10</sup>

**Climate Change:** The activities of the transport industry release several million tons of gases each year into the atmosphere, accounting for between 25% and 30% of all greenhouse gas emissions. These emissions are linked to climate change and some gases, particularly nitrogen oxide also contribute to the depleting stratospheric ozone (O<sub>3</sub>) layer, which naturally protects the earth's surface from ultraviolet radiation.

**Air quality:** Highway vehicles, marine engines, locomotives and aircrafts are major sources of pollution, emitting harmful gases and particulate matters/emissions that affect air quality and can cause serious damage to our health. Sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) in the atmosphere form various acidic compounds that, when mixed with cloud water, form acid rain. Smog is a mixture of solid and liquid fog and smoke particles formed from the accumulation of carbon monoxide, ozone, hydrocarbons, volatile organic compounds, nitrogen oxides, sulfur oxide, water, particulates and other chemical pollutants.

**Noise:** Noise generated by transport vehicles and port operations, airports and rail yards affects human health and increases the risk of cardiovascular diseases. Ambient noise is a common result of road transportation in urban areas. The cumulative outcome of all the noise generated by vehicles decreases quality of life.

**Water quality:** Transport activities have an impact on hydrological conditions and water quality. Fuel, chemicals and other hazardous particulates discarded from aircrafts, cars, trucks and trains, or from port and airport terminal operations, can contaminate water systems. Marine transport emissions has the largest impact on water quality impact among all other forms of transportation. Furthermore, different types of

garbage, containing metals or plastic, pose a serious threat on marine ecosystems and water quality.

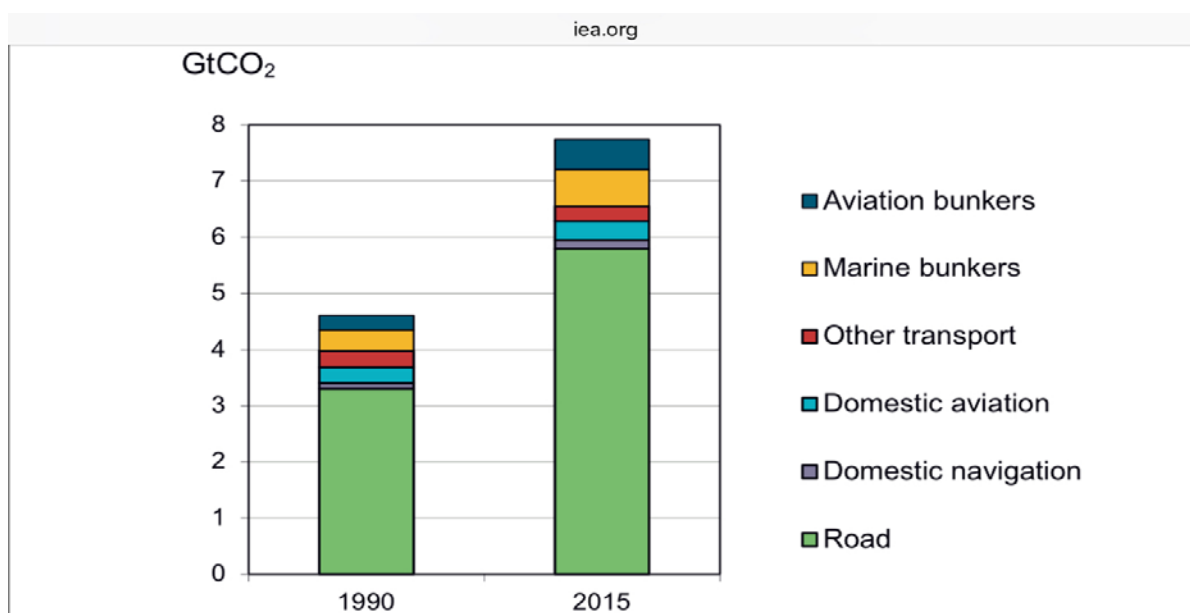
**Soil quality:** Transportation has an impact on soil quality, particularly soil erosion and soil contamination. Coastal transport facilities significantly impact soil erosion. Highway construction and the lessening of surface grades for port and airport development have led to a significant loss of fertile land.

**Biodiversity:** Transportation also impacts biodiversity. The need for construction materials and the development of land-based transportation has led to deforestation. Many transport routes have required land draining, thus reducing wetland areas and driving out water plant species.

**Land occupancy:** Transportation also has an impact on the urban landscape. Major transport facilities can impact the quality of urban life by creating more physical barriers, increasing noise levels, generating odours, reducing the visual appeal of the area, and affecting heritage.

## Attachment D

For transportation, the 68% increase since 1990 (Figure 4) was led by increasing emissions from the road sector, which accounted for three-quarters of total transport emissions in 2015. Despite efforts to limit emissions from international modes of transport, between 1990 and 2015, emissions by marine and aviation bunkers rose even faster compared to road transport (marine: +77% aviation: +105%).<sup>6</sup>



**Figure 4. CO<sub>2</sub> emissions from transport, 1990-2015**

(Source: International Energy Agency, Publication: CO<sub>2</sub> Emissions From Fuel Combustion Highlights 2017, page no. 14)

## Resources

- **If you are interested to read more about electric cars, have a look at the following links:**
  1. <http://www.iea.org/topics/transport/evi/>
  2. [https://en.wikipedia.org/wiki/Electric\\_vehicle](https://en.wikipedia.org/wiki/Electric_vehicle)
  3. <https://www.justenergysolutions.com/electric-vehicles-pros-cons/>
- **If you are interested to read more about hydrogen fuel and vehicles that use hydrogen, have a look at the following links:**
  1. [https://www.eia.gov/energyexplained/index.cfm?page=hydrogen\\_use](https://www.eia.gov/energyexplained/index.cfm?page=hydrogen_use)
  2. [https://en.wikipedia.org/wiki/Hydrogen\\_vehicle](https://en.wikipedia.org/wiki/Hydrogen_vehicle)

## References

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11. <http://vikaspedia.in/energy/energy-conservation/energy-conservation-in-transport-sector/energy-conservation-in-transport-systems>



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